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Standard Recommended Practice for INDICATING WHICH PLACES OF FIGURES ARE TO BE CONSIDERED SIGNIFICANT IN SPECIFIED LIMITING VALUES[1]

This Standard is issued under the fixed designation E 29; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval.

1. Scope

1.1 This recommended practice is intended to assist the various technical committees in the use of uniform methods of indicating the number of places of figures which are to be considered significant in specified limiting values, for example, specified maximum values and specified minimum values. Its aim is to outline methods which should aid in clarifying the intended meaning of specified limiting values with which observed values or calculated values obtained from tests are compared in determining conformance with specifications. Reference to this practice is valid only when a choice of method has been indicated, that is, either *absolute method or rounding-off method.*

1.2 This recommended practice is intended to be used in determining conformance with specifications when the applicable ASTM specifications or standards make direct reference to this practice.

1.3 This recommended practice describes two commonly accepted methods of rounding data, identified as the Absolute Method and the Rounding-Off Method. In the application of this practice to a specific material or materials it is essential to specify which method is intended to apply. In the absence of such specification reference to this recommended practice, which expresses no preference as to which method should apply, would be meaningless. The choice of method is arbitrary, depending upon the current practice of the particular branch of industry or technology concerned, and should therefore be specified in the prime publication.

2. Expression of Numerical Requirements

2.1 The unqualified statement of a numerical limit, such as "2.50 in. max", cannot, in view of different established practices and customs, be regarded as carrying a definite operational meaning concerning the number of places of figures to be retained in an observed or a calculated value for purposes of determining conformance with specifications.

2.2 *Rounding-Off Method*—In some fields, specified limiting values of 2.5 in. max, 2.50 in. max, 2.500 in. max are taken to imply that, for the purposes of determining conformance with specifications, an observed value or a calculated value should be rounded off to the nearest 0.1 in., 0.01 in., 0.001 in., respectively, and then compared with the specified limiting value. This will be referred to as the *rounding-off method.*

2.3 *Absolute Method*—In other fields, specified limiting values of 2.5 in. max, 2.50 in. max, and 2.500 in. max are all taken to imply the same absolute limit of exactly two and a half inches and for purposes of determining conformance with specifications, an observed value or a calculated value is to be compared directly with the specified value. Thus, any deviation, however small, outside the specified limiting value signifies nonconformance with the specifications. This will be referred to as the *absolute method.*

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[1] This recommended practice is under the jurisdiction of ASTM Committee E-11 on Statistical Methods.

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3. Rounding-Off Method

3.1 *Where Applicable*—The rounding-off method applies where it is the intent that a limited number of places of figures in an observed value or a calculated value are to be considered significant for purposes of determining conformance with specifications.

3.2 *How Applied*—With the rounding-off method, an observed value or a calculated value should be rounded off by the procedure prescribed in 2.2 to the nearest unit in the designated place of figures stated in the standard, as, for example, "to the nearest 100 psi," "to the nearest 10 ohms," "to the nearest 0.1 percent," etc. The rounded-off value should then be compared with the specified value, and conformance or nonconformance with the specification based on this comparison.

3.3 *How Expressed*—This intent may be expressed in the standard in one of the following forms:

3.3.1 If the rounding-off method is to apply to all specified limits in the standard, and if all figures expressed in the limiting value are to be considered significant, this may be indicated by including the following statement in the standard:

The following applies to all specified limits in this standard: For purposes of determining conformance with these specifications, an observed value or a calculated value shall be rounded off "to the nearest unit" in the last right-hand place of figures used in expressing the limiting value, in accordance with the rounding-off method of ASTM Recommended Practice E 29, for Indicating Which Places of Figures Are to Be Considered Significant in Specified Limiting Values.

3.3.2 If the rounding-off method is to apply only to the specified limits for certain selected requirements, this may be indicated by including the following statement in the standard:

The following applies to specified limits for requirements on (tensile strength), (elongation), and (.....) given in ....., (applicable section number and title) and (..... .....) of this standard: For purposes of determining conformance with these specifications, an observed value or a calculated value shall be rounded off to the nearest (1000 psi) for (tensile strength), to the nearest (1 percent) for (elongation), and to the nearest (.....) for (.....), in accordance with the rounding-off method of ASTM Recommended Practice E 29, for Indicating Which Places of Figures Are to Be Considered Significant in Specified Limiting Values.

3.3.3 If the rounding-off method is to apply to all specified limits in a table, this may be indicated by a note in the manner shown in the following examples:

3.3.3.1 *Example 1*—Same significant places for all items:

	Chemical Composition, percent
Copper	4.5 ± 0.5
Iron	1.0 max
Silicon	2.5 ± 0.5
Other constituents (magnesium + zinc + manganese)	0.5 max
Aluminum	remainder

NOTE—For purposes of determining conformance with these specifications, an observed value or a calculated value shall be rounded off to the nearest 0.1 percent, in accordance with the rounding-off method of ASTM Recommended Practice E 29, for Indicating Which Places of Figures Are to Be Considered Significant in Specified Limiting Values.

3.3.3.2 *Example 2*—Significant places not the same for all items; similar requirements:

	Chemical Composition, percent	
	min	max
Nickel	57	...
Chromium	14	18
Manganese	...	3
Silicon	...	0.40
Carbon	..	0.25
Sulfur	...	0.03
Iron	remainder	

NOTE—For purposes of determining conformance with these specifications, an observed value or a calculated value shall be rounded off "to the nearest unit" in the last right-hand place of figures used in expressing the limiting value, in accordance with the rounding-off method of ASTM Recommended Practice E 29, for Indicating Which Places of Figures Are to Be Considered Significant in Specified Limiting Values.

3.3.3.3 *Example 3*—Significant places not the same for all items; dissimilar requirements:

	Tensile Requirements
Tensile strength, psi	60 000 to 72 000
Yield point, min, psi	33 000
Elongation in 2 in., min, percent	22

NOTE—For purposes of determination of conformance with these specifications, an observed value or a calculated value shall be rounded off to the nearest 1000 psi for tensile strength and yield point and to the nearest 1 percent for elongation, in accordance with the rounding-off method of ASTM Recommended Practice E 29 for Indicating Which Places of Figures Are to Be Considered Significant in Specified Limiting Values.

3.4 *Rounding-Off Procedure*—The actual rounding-off procedure[2] shall be as follows:

3.4.1 When the figure next beyond the last place to be retained is less than 5, retain unchanged the figure in the last place retained.

3.4.2 When the figure next beyond the last place to be retained is greater than 5, increase by 1 the figure in the last place retained.

3.4.3 When the figure next beyond the last place to be retained is 5, and there are no figures beyond this 5, or only zeros, increase by 1 the figure in the last place retained if it is odd, leave the figure unchanged if it is even. Increase by 1 the figure in the last place retained, if there are figures beyond this 5.

3.4.4 This rounding-off procedure may be restated simply as follows: When rounding off a number to one having a specified number of significant places, choose that which is nearest. If two choices are possible, as when the digits dropped are exactly a 5 or a 5 followed only by zeros, choose the one ending in an even digit. Table 1 gives examples of applying this rounding-off procedure.

3.5 The rounded-off value should be obtained in one step by direct rounding off of the most precise value available and not in two or more steps of successive roundings. For example: 89,490 psi rounded off to the nearest 1000 psi is at once 89,000; it would be incorrect to round off first to the nearest 100, giving 89,500 and then to the nearest 1000, giving 90,000.

3.6 *Special Case, Rounding Off to the Nearest 50, 5, 0.5, 0.05 etc.*—If in special cases it is desired to specify rounding off to the nearest 50, 5, 0.5, 0.05, etc., this may be done by so indicating in the standard. In order to round off to the nearest 50, 5, 0.5, 0.05, etc., double the observed or calculated value, round off to the nearest 100, 10, 1.0, 0.10, etc., in accordance with the procedure in 3.4, and divide by 2. For example, in rounding off 6025 to the nearest 50, 6025 is doubled giving 12,050 which becomes 12,000 when rounded off to the nearest 100 (3.4.3). When 12,000 is divided by 2, the resulting number, 6000, is the rounded-off value of 6025. In rounding off 6075 to the nearest 50, 6075 is doubled giving 12,150 which becomes 12,200 when rounded off to the nearest 100 (3.4.3). When 12,200 is divided by 2, the resulting number, 6100, is the rounded-off value of 6075.

4. Absolute Method

4.1 *Where Applicable*—The absolute method applies where it is the intent that all digits in an observed value or a calculated value are to be considered significant for purposes of determining conformance with specifications. Under these conditions, the specified limits are referred to as absolute limits.

4.2 *How Applied*—With the absolute method, an observed value or a calculated value is not to be rounded off, but is to be compared directly with the specified limiting value. Conformance or nonconformance with the specification is based on this comparison.

4.3 *How Expressed*—This intent may be expressed in the standard in one of the following forms:

4.3.1 If the absolute method is to apply to all specified limits in the standard, this may be indicated by including the following sentence in the standard:

> For purposes of determining conformance with these specifications, all specified limits in this standard are absolute limits, as defined in ASTM Recommended Practice E 29, for Indicating Which Places of Figures Are to Be Considered Significant in Specified Limiting Values.

4.3.2 If the absolute method is to apply to all specified limits of some general type in the standard (such as dimensional tolerance limits), this may be indicated by including the following sentence in the standard:

> For purposes of determining conformance with these specifications, all specified (dimensional tolerance) limits are absolute limits, as defined in ASTM Recommended Practice E 29, for Indicating Which Places of Figures Are to Be Considered Significant in Specified Limiting Values.

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[2] The rounding-off procedure given in this recommended practice is the same as the one given in the American National Standard Rules for Rounding Off Numerical Values (ANSI Z25.1) and in the *ASTM Manual on Quality Control of Materials, STP 15-C*, Part 2, Section 7 (1951).

4.3.3 If the absolute method is to apply to all specified limits given in a table, this may be indicated by including a footnote with the table as follows:

Width, in.	Width Tolerances[a] Plus and Minus, in.	
	0.032 in. and under in Thickness	Over 0.032 in. in Thickness
2 and under	0.005	0.010
Over 2 to 8 incl	0.008	0.013
Over 8 to 14 incl	0.010	0.015
Over 14 to 20 incl	0.013	0.018

[a] Tolerance limits specified are absolute limits as defined in ASTM Recommended Practice E 29, for Indicating Which Places of Figures Are to Be Considered Significant in Specified Limiting Values.

TABLE 1 Examples of Rounding off

Specified Limit	Observed Value or Calculated Value	To Be Rounded Off to Nearest	Rounded-Off Value to be Used for Purposes of Determining Conformance	Conforms with Specified Limit
Tensile strength, 60 000 psi, min	59 940	100 psi	59 900	no
	59 950	100 psi	60 000	yes
	59 960	100 psi	60 000	yes
Nickel, 57 percent, min	56.4	1 percent	56	no
	56.5	1 percent	56	no
	56.6	1 percent	57	yes
Water extract conductivity, 40 micromhos/cm, max	40.4	1 micromho/cm	40	yes
	40.5	1 micromho/cm	40	yes
	40.6	1 micromho/cm	41	no
Sodium bicarbonate 0.5 percent, max	0.54	0.1 percent	0.5	yes
	0.55	0.1 percent	0.6	no
	0.56	0.1 percent	0.6	no